The FIRST Efficient Lens Survey

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Abstract. We have found three lenses (two are new) by observing 34 likely FIRST radio lobes with APM galaxy counterparts. We expect to find ~ 30 such lenses in over the next few years, which will significantly improve lensing constraints on galaxy structure and cosmology.

Although ∼70% of lensed radio sources should be radio lobes (Kochanek & Lawrence 1990) few have been found. In fact, many radio searches (e.g., CLASS, see Rusin et al. in these proceedings) select only flat-spectrum sources, thereby eliminating the dominant type of lensed radio source.

Lensed lobes can be found efficiently because they usually lie *outside* their host galaxy. If a galaxy is coincident with a radio lobe, it is likely to be a foreground lens, as in MG 1549+3047 (Lehár et al. 1993). Moreover, lensed lobes are ideal for studying galaxy mass distributions because, unlike most flat-spectrum sources, their extended structure can yield many lens model constraints.

We searched the FIRST survey (Becker et al. 1995), then covering ~ 3000 square degrees, for likely radio lobes with coincident galaxies in the APM catalog (McMahon & Irwin 1992). There were 845 double and colinear triple FIRST sources with an $R \lesssim 20$ mag APM galaxy within $2''$ of a presumed lobe's peak. The FIRST survey can't definitively identify components as lobes, nor can it resolve $\sim 1''$ lensed structures, so higher resolution observations were necessary.

We obtained confirming VLA 6 cm observations (9 archival, 25 new) for those 34 candidates whose lobes were bright enough (100 mJy) to find rings similar to that in MG 1549+3047, using < 30 min integrations. We also observed 3 targets with MERLIN at 18 cm, and optical images or spectra were acquired for 4 targets. Most of our lobe candidates were ruled out as radio cores or independent radio sources.

Three candidates survived our selection. MG 1549+3047 is a known lens, and two new lenses, J0823+39 and J1622+35 (see Figure 1), also have galaxies both at the core and a radio lobe. Keck LRIS spectra of J1622+35 give lens and source redshifts of $z_l = 0.32$ and $z_s = 1.47$, and the distorted structures seen by MERLIN are easily reproduced by simple lens models.

About 10% of our VLA targets are lensed, compared to a success rate of only 0.2% for traditional lens searches. The sample can be expanded using larger radio surveys, fainter optical catalogs (e.g., POSS-II, Djorgovski et al., 1998; or SDSS, Gunn & Knapp, 1992), and deeper VLA confirmations. POSS-II should find $\sim 50\%$ more lens galaxies than the APM, so we should find ~ 30 lenses once FIRST is complete. Assuming our present VLA sensitivity cutoff, ~ 120 lenses could be found on the whole sky, using surveys like FIRST and SDSS. Such a sample would be a powerful probe of galaxy structure and evolution.

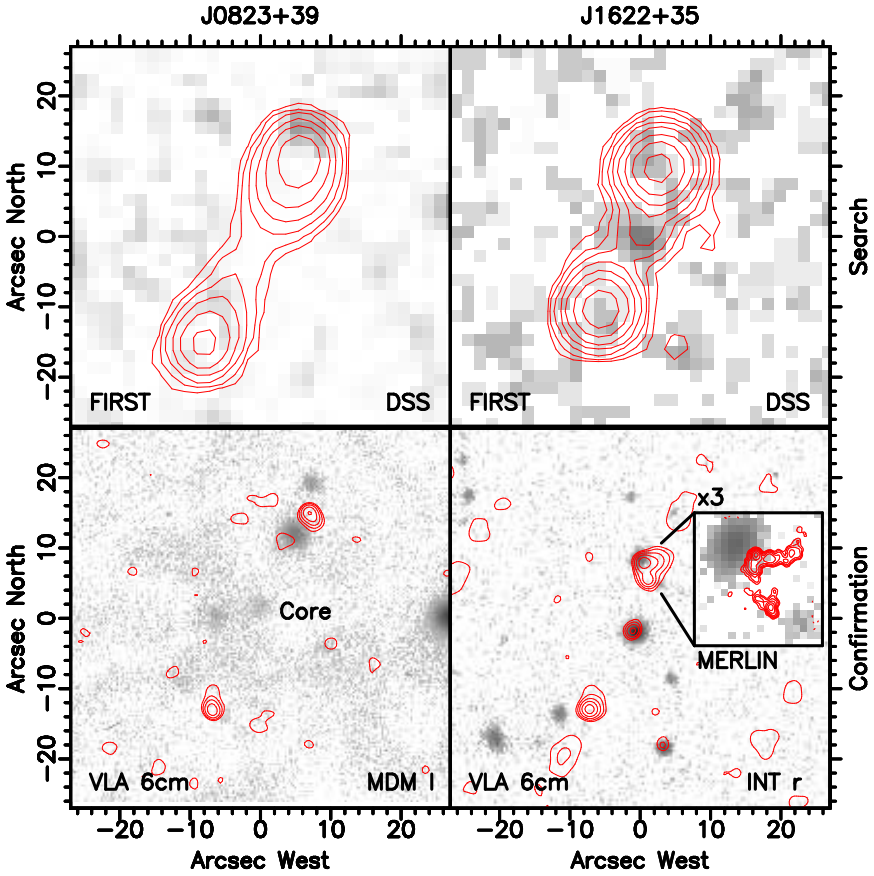

Figure 1. Search (top) and confirmation (bottom) maps for the two new lensed lobes. The optical images are in greyscale, and the radio flux contours are spaced by factors of 2. The images are astrometrically registered, and the VLA 6 cm maps were smoothed to 1.″6. The core of J0823+39 is seen in the full resolution VLA 6 cm map.

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